Polycarpelly in *Idiospermum australiense* (Calycanthaceae)

Stuart J. Worboys

Summary

Worboys, S.J. (2003). Polycarpelly in *Idiospermum australiense* (Calycanthaceae). *Austrobaileya* 6(3): 553–556. *Idiospermum australiense* (Diels) S.T. Blake (Calycanthaceae) is restricted to two relatively small regions in the lowland tropical rainforests of north-east Queensland, Australia. Previous morphological studies have focussed on specimens from the northernmost of these two regions. Examination of flowers from all known populations of the species revealed significant differences between the northern and southern regions with respect to numbers of floral parts, especially carpels. Polycarpelly was found to be widespread in the southern populations, a feature previously unreported in the literature.

Keywords: *Idiospermum,* polycarpelly, Queensland flora, Calycanthaceae, Idiospermoideae.

Stuart Worboys, School of Tropical Biology, James Cook University Cairns Campus, PO Box 6811, Cairns, Queensland, Australia; email: worboys1968@yahoo.com.au

Introduction

Idiospermum australiense (Diels) S.T. Blake is a geographically and taxonomically isolated tree species, restricted to very wet lowland mesophyll vine forests in north-east Queensland. It was first described by Ludwig Diels (1912) as *Calycanthus australiensis* and placed in the family Calycanthaceae, a group previously known only from eastern Asia and the southern United States (Nicely 1965). Diels, however, based his description on incomplete material. When complete fertile material became available, notably the enormous polycotyledonous embryos, its distinctiveness became apparent. In consequence, Blake (1972) erected a new family and genus: Idiospermaceae, *Idiospermum australiense*. The family Idiospermaceae, although recognised by some authors (Wilson 1976, Cronquist 1981), is now generally regarded as a subfamily, Idiospermoideae, of Calycanthaceae, as proposed by Thorne (1974), and later supported by Endress (1983) and Kubitzki (1993).

The type specimen of *Calycanthus australiensis* described by Diels (1912) was collected near the mouth of Harvey Creek, south of Cairns. Although insect damaged, Diels was able to make out two intact carpels. However, the specimens examined by Blake (1972) and Wilson (1976) were collected from the Daintree region, to the north of Cairns. Flowers from these populations were described as having 0 or 1 carpel, rarely two. Because of this, Blake (1972) considered *Idiospermum* to be taxonomically isolated, in particular noting that "... two combinations of characters appear to be unique to *Idiospermum* – numerous spiral tepals, hollowed receptacle and a single carpel, laminar stamens and absence of endosperm."

This note presents the results of investigations into floral morphology, which for the first time involves the examination of specimens from across the known range of the species. Consideration is given to the taxonomic implications of these studies. These data were collected as part of a broader study into the reproductive biology of the species.

Methods

Idiospermum occurs in two regions in the lowland wet tropical rainforests of north eastern Queensland. Two populations are known from the foothills of the Bellenden Ker Range to the south of Cairns (Russell River valley and Harvey Creek) while two larger populations occur in the coastal lowlands and foothills of the Daintree region (Cooper Creek catchment and Noah Creek catchment), to the north of Cairns. In total, the known extent of these populations is 22.5 km^2. Flowers were collected from across all populations.

Accepted for publication 13 June 2003

Flowering occurs annually, reaching a maximum intensity in June and July (Worboys 1998). Flowers were collected and examined while fresh or preserved in 70% ethanol. Counts were made of the following floral organs: outer hemispherical bracts, tepals, fertile stamens, staminodes and carpels (terminology follows that of Wilson 1976). For various reasons, including floral age and insect damage, not all features could be examined on all flowers. A small proportion of flowers contained small, narrow vestigial carpels, lacking ovules but occasionally bearing a stigma. Such carpels were considered to be sterile.

For the purposes of analysis, flowers were grouped into northern (north of Cairns) and southern (south of Cairns) populations. A total of 441 flowers from 20 northern trees and 144 flowers from 10 southern trees were examined. The location of the sampled trees is listed below. One way analysis of variance was used to compare the mean number of each floral organ, testing the null hypothesis that no difference existed between samples from northern and southern populations.

***Selected specimens*: (All Worboys collections): Queensland.** Cook District: Near Jiyer Cave, Russell River Valley 17°27'S, 145°47'E, Jun 1995, *SJW* 395 (BRI); Bruce Highway bridge over Harvey Creek, near Deeral, 17°15'S, 145°55'E, Jul 1995, *SJW* 396 (BRI); Harvey Creek, near Deeral, 17°15'S, 145°54'E, Jun 1994, *SJW* 397 (BRI); ditto, Jul 1995, *SJW* 398 (BRI); ditto, Jul 1995, *SJW* 399, (BRI, CANB); Near end of Carbeen Road, Cow Bay, 16°12'S, 145°25'E, Aug 1995, *SJW* 400 (BRI); ditto, Aug 1995, *SJW* 401 (BRI); On Little Cooper Creek at the top end of Turpentine Road, Cow Bay, 16°10'S, 145°25'E, Jul 1996, *SJW* 402 (CANB); ditto, Jun 1995, *SJW* 403 (BRI); ditto, Jul 1995, *SJW* 404 (BRI); Candlenut Road, Cow Bay, 16°10'S, 145°25'E, Aug 1996, *SJW* 405 (BRI); ditto, Jun 1995, *SJW* 411 (CANB); Lower reaches of Cooper Creek, Cow Bay, 16°10'S, 145°25'E, Aug 1995, *SJW* 407 (BRI, CANB); ditto, Jul 1995, *SJW* 410 (BRI); Oliver Creek, approx 100m N of Maardja Boardwalk car park, 16°9'S, 145°24'E, Aug 1995, *SJW* 408 (BRI); ditto, Aug 1995, *SJW* 412 (BRI); Lower reaches of Noah Creek, near Cape Tribulation, 16°9'S, 145°25'E, Aug 1995, *SJW* 409 (BRI); ditto, Aug 1995, *SJW* 413 (BRI).

Results and Discussion

Flowers from northern populations of *Idiospermum australiense* are markedly different from those of southern populations (**Table 1**). They have, on average, fewer tepals, more stamens, and most significantly, fewer carpels (**Fig 1**).

It has previously been reported that, in collections from trees in the northern populations, both male and hermaphrodite flowers occur on the same tree (Blake 1972, Endress 1983), *i.e.* these populations are andromonoecious. This study confirms these observations, with 55.7% of flowers collected

Character	Northern Populations	Southern Populations	ANOVA	
			df	*F*
Tepals (not including basal pairs)	42.45 (92) 34–52	38.71 (62) 32–48	1, 152	50.778*
Functional stamens	14.45 (282) 10–20	13.61 (144) 10–17	1, 424	32.238*
Staminodes	17.07 (230) 8–28	16.71 (63) 8–23	1, 291	0.492
Carpels	0.51 (404) 0–2	2.33 (144) 1–5	1, 461	610.3*

Table 1. Comparisons of the number of floral organs found in flowers of *Idiospermum*. Values are mean (sample size), with the range of observed values immediately below. * indicates $P < 0.001$.

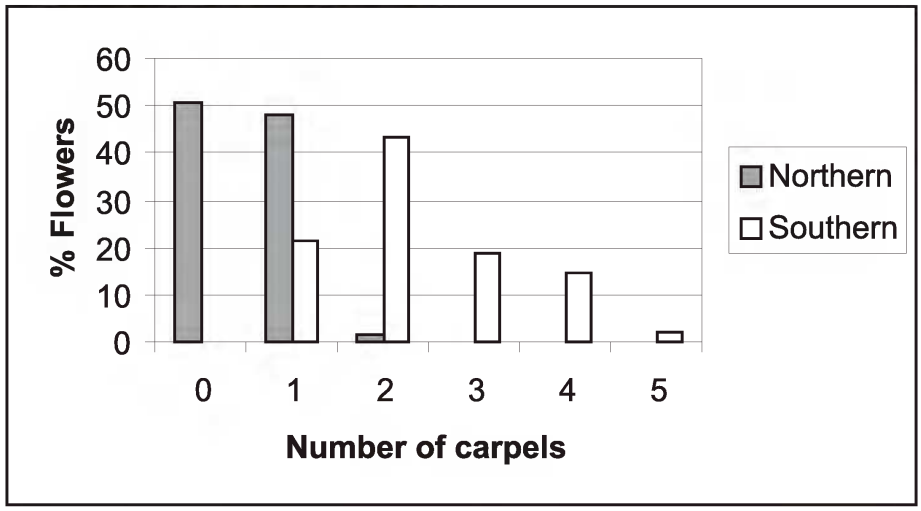

Figure 1. Number of carpels per flower, and proportion of flowers bearing that number in *Idiospermum* flowers from northern and southern populations.

from northern trees lacking functional carpels. In contrast, all flowers from southern populations were carpellate. A significant proportion of these had three carpels (Figure 1), a character state previously noted as unusual or rare (Cronquist 1981). One of the southern trees (*SJW* 397) bore flowers with up to five carpels.

The discovery of polycarpelly as a common feature in *Idiospermum* informs the debate regarding the family status of Idiospermaceae. The significance of the characters used to separate the family has been subject to varying interpretations by different authors. Thus, in comparative studies of *Idiospermum* and its temperate-zone northern hemisphere relatives (Calycanthaceae *sensu stricto*), differences have been noted in aspects of vegetative habit (Wilson 1979, Kubitzki 1993), floral anatomy and morphology (Blake 1972, Wilson 1976, Friis *et al.* 1994, Endress and Igersheim 1997), seed characteristics (Blake 1972, Wilson 1979), phytochemicals (Sterner and Young 1980), and gene sequence data (Ablett *et al.* 1997, Renner 1999). However, many morphological differences have been attributed to adaptations to contrasting moist tropical, and cool temperate, drought-prone environments, and that "[to] recognize the Idiospermaceae as a separate family overstresses the multiple expressions of a single basic difference, the tropical rainforest ecology of *Idiospermum* and the adaptations to that habitat." (Carlquist 1983). Similarly, the significance of the chemical dichotomies noted by Sterner and Young (1980) has also been discounted, on the basis that similar differences can be found within a single genus, or in different populations of the same species (Kubitzki 1993). Renner's (1999) analyses, based on sequence data and morphological character states, group *Idiospermum* with the Calycanthaceae. The degree of divergence between *Idiospermum* and Calycanthaceae *sensu stricto*, is less than that present within, for example, the Lauraceae and the Monimiaceae. Renner (1999) notes that "whether or not ... *Idiospermum* is recognized as a family (Idiospermaceae) depends on taste...".

Two unambiguous character combinations were cited by Blake (1972) as unique to the Idiospermaceae - laminar stamens and absence of endosperm, and numerous spiral tepals, hollowed receptacle with a single carpel. However, evidence gathered recently has called into question the significance of these character combinations. Friis *et al.* (1994)

reported laminar stamens in combination with Calycanthaceae-like floral features in a fossilised calycanthaceous flower (although the poor state of gynoecial preservation did not permit the confirmation of the presence or absence of endosperm). The authors of this paper concluded that, given the character combination seen in the fossil, the separation of *Idiospermum* from Calycanthaceae *sensu stricto* was poorly supported. The presence of polycarpelly in southern populations of *Idiospermum* indicates a higher degree of diversity in this character than has previously been reported. Evidence presented here shows that the character combination of numerous spiral tepals, hollowed receptacle and a single carpel is not a unique and definitive feature of the species, and cannot therefore be utilised in support of the family Idiospermaceae.

Acknowledgments:

This work was funded by the Wet Tropics Management Authority, CRC Rainforest and James Cook University grants. Thanks to Betsy Jackes and Paul Gadek for reviewing the manuscript. Thanks to Rigel Jensen and Bob Jago for guiding me to the southern populations, and Andrew Small for introducing me to the Daintree populations. Resi Schwarzbauer and Barbara Paulus translated Diels' original German description.

References:

Ablett, E.M., Playford, J. and Mills, S. (1997) The use of rubisco DNA sequences to examine the systematic position of *Hernandia albiflora* (C.T. White) Kubitzki (Hernandiaceae), and relationships among the Laurales. *Austrobaileya* 4:601–607.

Blake, S.T. (1972) *Idiospermum* (Idiospermaceae), a new genus and family for *Calycanthus australiensis*. *Contributions from the Queensland Herbarium* No. 12:1–37.

Carlquist, S. (1983) Wood anatomy of Calycanthaceae: Ecological and systematic implications. *Aliso* 10:427–441.

Cronquist, A. (1981) *An Integrated System of Calssification of Flowering Plants*. New York: Columbia University Press.

Diels, L. (1912) Über primitive Ranales der australischen Flora: 1. Die Auffindung von *Calycanthus* im australischen Regenwald. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie: Beiblatt zu den Botanischen Jahrbüchern* Nr. 107:7–13.

Endress, P.K. (1983) Dispersal and distribution in some small archaic relic angiosperm families (Austrobaileyaceae, Eupomatiaceae, Himantandraceae, Idiospermoideae-Calycanthaceae). *Sonderbaende naturwissenschaftlicher Verein, Hamburg* 7:201–217.

Endress, P.K. and Igersheim, A. (1997) Gynoecium diversity and systematics of the Laurales. *Botanical Journal of the Linnean Society* 125:93–168.

Friis, E.M., Eklund, H., Pedersen, K.R. and Crane, P.R. (1994) *Virginianthus calycanthoides gen. et sp. nov.* – A calycanthaceous flower form the Potomac Group (early Cretaceous) of eastern North America. *International Journal of Plant Sciences* 155:772–785.

Kubitzki, K. (1993) *Calycanthaceae*. In, K. Kubitzki, J.G. Rohwer and V. Bittrich (Editors): *The Families and Genera of Vascular Plants*. Volume II. Flowering Plants - Dicotyledons: Magnoliid, Hamamelid and Caryophyllid Families. Berlin: Springer-Verlag.

Nicely, K.A. (1965) A monographic study of the Calycanthaceae. *Castanea* 30: 38–81.

Renner, S.S. (1999) Circumscription and phylogeny of the Laurales: evidence from molecular and morphological data. *American Journal of Botany* 86:1301–1315.

Sterner, R.W. and Young, D.A. (1980) Flavonoid chemistry and the phylogenetic relationships of the Idiospermaceae. *Systematic Botany* 5:432–437.

Thorne, R.F. (1974) A phylogenetic classification of the Annoniflorae. *Aliso* 8: 147–209.

Wilson, C.L. (1976) Floral anatomy of *Idiospermum australiense* (Idiospermaceae). *American Journal of Botany* 63:987–996.

Wilson, C.L. (1979) *Idiospermum australiense* (Idiospermaceae) – aspects of vegetative anatomy. *American Journal of Botany* 66:280–289.

Worboys, S.J. (1998) Pollination processes and population structure of *Idiospermum australiense* (Diels) S.T. Blake, a primitive tree of the Queensland Wet Tropics. Unpublished M.Sc. Thesis. James Cook University of North Queensland, Cairns Campus.